

Construct Validity of an Inanimate Training Model for Laparoscopic Appendectomy

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ABSTRACT

Background and Objective: The use of training models in laparoscopic surgery allows the surgical team to practice procedures in a safe environment. The aim of this study was to determine the capability of an inanimate laparoscopic appendectomy model to discriminate between different levels of surgical experience (construct validity).

Methods: The performance of 3 groups with different levels of expertise in laparoscopic surgery—experts (Group A), intermediates (Group B), and novices (Group C)—was evaluated. The groups were instructed of the task to perform in the model using a video tutorial. Procedures were recorded in a digital format for later analysis using the Global Operative Assessment of Laparoscopic Skills (GOALS) score; procedure time was registered. The data were analyzed using the analysis of variance test.

Results: Twelve subjects were evaluated, 4 in each group, using the GOALS score and time required to finish the task. Higher scores were observed in the expert group, followed by the intermediate and novice groups, with statistically significant difference. Regarding procedure time, a significant difference was also found between the groups, with the experts having the shorter time. The proposed model is able to discriminate among individuals with different levels of expertise, indicating that the abilities that the model evaluates are relevant in the surgeon's performance.

Conclusions: Construct validity for the inanimate full-task laparoscopic appendectomy training model was

demonstrated. Therefore, it is a useful tool in the development and evaluation of the resident in training.

Key Words: Training, Appendectomy, Laparoscopy.

INTRODUCTION

Laparoscopic appendectomy is the standard treatment for acute appendicitis, offering the benefits of minimally invasive surgery: less morbidity, decreased postoperative pain, shorter postoperative hospital stay, faster return to normal activities, and optimal cosmetic outcome.¹ Performing laparoscopic procedures requires special surgical skills to overcome the technical difficulties that it presents, which include 2-dimensional vision with loss of depth perception, less range of motion of the instruments when compared with open surgery, impaired tactile sensation, and the disparity between visual and proprioceptive feedback known as the *fulcrum effect*.^{2,3}

Traditionally, most of the surgical training in hospitals has been done in the operating room under the supervision of a senior surgeon, but, ideally, it must be done in a skills laboratory. Training programs have been designed for this mean using animal or inanimate bench models and, more recently, virtual simulators. These have been proven to help contribute to the acquisition of skills and dexterity to perform laparoscopic procedures and to progress in the learning curve.^{4,5} Models and simulators allow for proper training and also offer an objective evaluation of the surgeon's competence; however, validation must be obtained to determine their value and reliability as practice and assessment tools.⁶ There are several parameters for this validation. Construct validity is one of the most important of these and consists of the capability of the model to detect discrepancies between subjects with different levels of experience. This way, if the model can discriminate between novice and expert surgeons, it could be used as an objective evaluation tool to assess the skill level of the surgeon in training and his or her progress during the practice period with the model.^{6,7}

The ideal model or simulator generates objective and reliable feedback that allows for the prediction of surgical

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performance during an in vivo procedure.⁸ We have proposed an inanimate, simple, readily available, and low-cost model that allows the surgeon to emulate the fundamental steps of an appendectomy.⁹ The objective of this study was to validate such a model by determining its ability to discriminate between subjects with different levels of experience (construct validity).

METHODS

This was an experimental study. Twelve subjects were evaluated—distributed into 3 groups with different levels of experience.

Group A

Novice: Four first-year surgery residents without any experience in laparoscopic surgery.

Group B

Intermediate: Four second-year surgery residents trained in basic laparoscopic surgery.

Group C

Expert: Four senior surgeons with experience in advanced laparoscopic surgery.

Instructions were provided with a video tutorial of the tasks to be performed in the model. Practice sessions took place in the Surgery Department III of the University Hospital of Caracas, and were recorded in a digital format for later analysis using the Global Operative Assessment of Laparoscopic Skills (GOALS) score (**Table 1**) and time taken to finish the task.

Model Description

A model was designed with low-cost and readily available surgical material. A black box was needed for construction of the model; often used for laparoscopic technique practice, this box is available in most surgical centers (**Figure 1**). A simulated appendix was created by stuffing one finger of a latex glove with foam rubber taken from a surgical scrubbing brush. This material was also used to emulate the mesoappendix and was sewn to the “appendix” (**Figure 2**). Another latex glove was used to imitate the small bowel. The instruments used were the same as those used in a basic laparoscopic appendectomy: Babcock grasper, ENDLOOP ligature (Ethicon, Cincinnati, OH), clipper, and scissors. The fundamental steps of a laparoscopic appendectomy are reproduced in this model.

Identification and Handling of the Appendix

The synthetic appendix was placed into a retrocecal position. Another latex glove was placed over it to simulate the small bowel so that handling with atraumatic clamps could be practiced. This step was crucial for identification of the appendix. Once the bowel was mobilized, the appendix was grasped and exposed.

Control of the Appendicular Artery and Mesoappendix

With the appendix exposed, the mesoappendix was grasped and clips placed in the same fashion as in vivo surgery to ligate the appendicular artery. Next, the mesoappendix was divided. Control of the mesoappendix can also be practiced using dissecting and hemostatic

Table 1.
Global Operative Assessment of Laparoscopic Skills

Domains Handling	Depth Perception	Bimanual Dexterity	Efficiency	Tissue Handling	Autonomy
1	Constantly overshooting target	Use of one hand	Uncertain, much wasted effort	Rough movements	Unable to complete entire procedure
2					
3	Some overshooting or missing plane, corrects quickly	Nonoptimal use of both hands	Slow but planned movements	Handles tissue reasonably well	Able to complete operation safely
4					
5	Accurately directs instruments in correct plane to target	Expert use of both hands	Confident, efficient and safe conduct of operation	Handles tissue very well	Able to complete operation independently



Figure 1. Model. Black box and laparoscopic instruments.

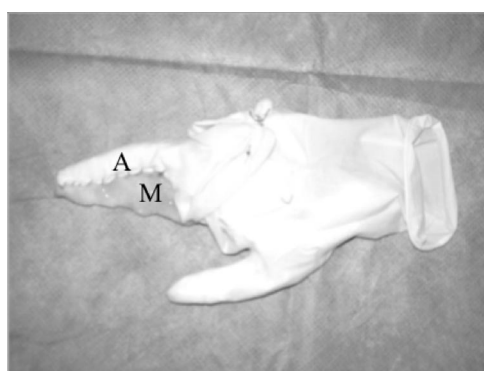


Figure 2. Appendix model. A = appendix; M = mesoappendix.

instruments such as a Harmonic scalpel (Ethicon) or LigaSure (Covidien, Boulder, CO).

ENDOLOOP Placement

This model allowed the surgeon to practice placing the ENDOLOOP around the base of the appendix. Lack of familiarization with this instrument tends to make this an intricate step. After the ENDOLOOP was deployed, a clip was placed distal to it and the appendix was sectioned with scissors.

Piece Extraction

It is important to mention that the appendix must be extracted through the trocar to avoid any contact with the abdominal wall to prevent infection of the surgical site.

Data were analyzed using the analysis of variance test. Graphic exploratory analysis was made.

RESULTS

Twelve subjects were evaluated, distributed into 3 groups with different levels of experience (novice, in-

termediate, expert). Evaluation was made using the GOALS score and registered procedure time. Comparing the performance of the 3 groups, the P value (.00) of the test indicates that for any level of significance “there is sample evidence that allows us to conclude that the subject’s expertise influences the total obtained score.” Thus, experts have the highest scores followed by the intermediate and, finally, the novice surgeons (Figures 3 and 4).

DISCUSSION

Minimally invasive surgery techniques in abdominal surgery are a great advancement in general surgery; however, the safety and success of procedures requires surgical team training.

Traditionally, instruction in specific surgical training was based on a Halsted’s “see one, do one, teach one” classic

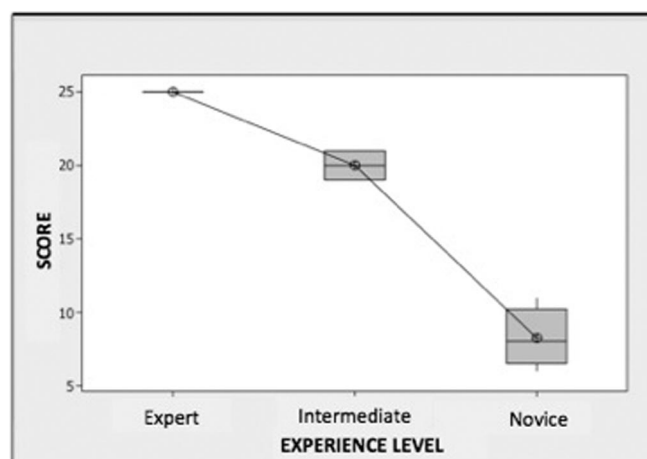


Figure 3. GOALS scores.

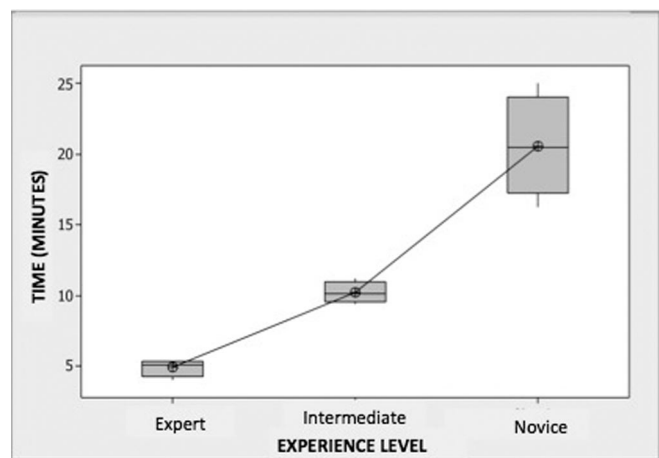


Figure 4. Time required to finish the entire task.

scheme in which residents perform operations under the tutelage of senior faculty surgeons.¹⁰ This has proven to be inefficient regarding cost, time, schedule restriction, safety, and even ethical implications, and this forced surgeons to innovate and develop new methods of surgical training.^{11,12}

Models and simulators permit constant and systematic training, which allows the evaluation and certification of the competence of a surgeon; however, these models require validation. The validation of a simulator requires evaluation of the quality of such system as a tool of training and certification. This process comprises multiple aspects, such as reliability, resemblance to the in vivo procedure (face validity), the possibility of obtaining facts that can be interpreted, and the capacity of the model to differentiate among surgeons with different levels of expertise (construct validity). Construct validity results in the applicability of the tool as a means to evaluate the development of skills while practicing them.⁶

If the model does not detect variations between novices and experts, then it would not be able to evaluate the progress of individuals who are using it only as an exercise tool. Conversely, if the parameters that the model contemplates are useful to differentiate novices from experts, this will become useful to objectively classify the level of competence of a surgeon and furthermore evaluate the surgeon's progress over time.

A variety of systems have been created, from animal, cadaver, and inanimate models to virtual reality simulators. The latter have the advantage of immediate evaluation of the trainee. However, all of these tools are expensive and unavailable in most health centers.^{4,5} We propose

an inanimate, simple, readily available, and low-cost model for the practice of the fundamental steps of laparoscopic appendectomy.

In this study, evaluation using the GOALS score and registered procedure time showed a difference between expert, intermediate, and novice surgeon groups. This indicates that the model proposed by the author is a useful tool for the evaluation of laparoscopic skills. Thus, training with the model and systematic evaluation will determine trainees' evolution until the necessary skills are acquired to safely perform an appendectomy.

The evaluated training model is categorized as a full-task simulator oriented to a specific procedure, which in comparison makes it superior to other models that only evaluate common activities for different types of surgeries.

Simulation and practice are highly relevant in teaching laparoscopic surgery. The benefits of deliberated practice before real-life performances have been demonstrated in other fields such as sports, music, and aviation. General surgery programs must include step-by-step learning of laparoscopic surgery. Practice outside the operating room must not be optional—it must be obligatory in the surgeon's formation.

CONCLUSION

Construct validity for the inanimate full-task laparoscopic appendectomy training model was demonstrated. Therefore, it is a useful tool in the development and evaluation of the resident in training.

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